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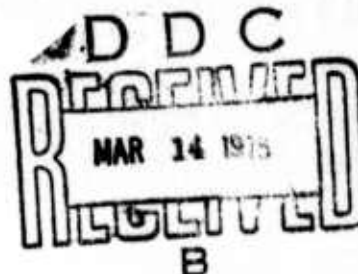
The Regents of the University of California  
University of California, San Diego  
Marine Physical Laboratory of the  
Scripps Institution of Oceanography  
La Jolla, California

TECHNICAL REPORT

February 28, 1973

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## Introduction

Our two-wavelength radiometer ( $\lambda_1 = 3.74 \mu$ ,  $\Delta\lambda_1 = .38 \mu$  FWHM;  $\lambda_2 = 4.82 \mu$ ,  $\Delta\lambda_2 = .43 \mu$  FWHM) and its new computerized data-acquisition/-logging system were installed on the Naval Undersea Center's Oceanographic Research Tower off the coast of San Diego on August 28, 1972. Beginning the next day, data was taken on 14 days during the following 6-week period. We also installed and logged the output of meteorological sensors to measure air temperature ( $T_A$ ), dew point ( $T_D$ ), wind speed ( $V$ ), bulk-water temperature ( $T_W$ ) and net radiative heat flux. N.U.C. provided a voltage input corresponding to the wind direction, and Scripps' Advanced Ocean Engineering Laboratory supplied outputs from a 31-element thermistor chain located directly beneath the sea surface in the radiometer's field of view. Another thermistor chain was mounted in the same location by N.U.C., who digitized and recorded their chain's output.

## Data Coverage

Radiometer data was recorded during the periods indicated in Table 1. The A.O.E.L.'s thermistor-chain outputs were recorded for all periods except August 30. It was discovered that overdriven channels caused electronic interfacing problems, thus making all data of August 29 suspect. Simultaneous meteorological data were also recorded: air temperature, dew point, and wind speed beginning September 12, and net radiative heat flux, wind direction and bulk-water temperature beginning September 25. In addition, strip-chart records were made of both wind speed and bulk water temperature for September 12-13, September 19 (1035-1521 hours, when no radiometric data was taken), September 25-26, September 28-29, October 3-4, and October 5-6.

## Instrument Descriptions

The two detectors of the two-wavelength radiometer are PbSe, thermoelectrically cooled to  $-80^\circ\text{C}$ . They share an optical system consisting of a relay lens pair and a mirror mounted on the shaft of a 60 cps synchronous

motor. The scan mirror is cut at a  $55^\circ$  angle to the optical axis, so that the centerline of the detectors' field of view describes a conical surface. The axis of the cone is horizontal; the apex half-angle is  $70^\circ$ . The detectors alternately view the ocean, one internal blackbody reference, the sky, and a second reference blackbody. A motor-shaft encoder puts out a pulse when viewing each target; the pulses fire sample-and-hold circuits in a 15-bit A/D converter as well as indicate which target is being observed. Each reference blackbody contains a thermistor bridge to measure its temperature, which is controlled by thermoelectric elements in a servo loop. Sixty-four samples of each target were averaged by the mini-computer (Nova 1220) used as a data logger, and the most significant 16 bits were written on magnetic tape for later analysis. Each physical tape record contains 15 averages and represents about 16.2 sec in real time.  $T_A$  and  $T_D$  were measured with a Cambridge model 110 system,  $V$  with a Teledyne-Geotek model 40.11 anemometer; the net radiative heat flux with a Teledyne-Geotek model TCN-188 net radiometer, and  $T_W$  by a thermistor at a depth of about 6 inches mounted on a float constrained to move primarily in the vertical direction. The thermistor float was initially mounted directly beneath the tower; on October 4 it was moved to a point approximately 8 feet north of the tower.

#### Data Reduction and Analysis

To date, over 90% of the radiometric tower data has been reduced into each of two forms: (1) computer print-outs giving the sky and water temperatures (the latter both with and without correction for the reflection of radiation from the sky off the water) at each of the two wavelengths, and (2) computer-generated plots of  $4.8\text{-}\mu$  water temperature and the difference in temperatures sensed at  $3.7\text{-}\mu$  ( $T_{1W}$ ) and at  $4.8\text{-}\mu$  ( $T_{2W}$ ) as functions of time. The plots have the same time-scale as the N.U.C. isotherm-height plots which they generated from their thermistor-chain data for all of our data-taking periods. A computer program has also been written (and debugged) for graphing and the meteorological data, but so far

we have produced only a handful of these plots.

The strip-chart records of wind speed ( $V$ ) and  $T_w$  show large variations in the bulk-water temperature: up to several tenths of a degree C over time intervals as short as a minute when the float was directly beneath the tower. Looking at these strip-charts, it appears that (1) there are large short-term variations in both temperature and wind speed. Sometimes they appear strongly correlated; however, at other times one varies while the other does not, or has no obvious correlation with the first; and (2) the bulk-water temperature fluctuations north of the tower appeared to be generally smaller than those measured directly beneath the tower. This may be a "real" effect, due simply to moving the float farther from the region in which the tower's legs caused mixing. It may, however, have been only an apparent effect, because the total observation time north of the tower was much less than the observation time directly beneath it.

### Conclusions

Careful visual comparison of graphs of  $T_{2W}$  with N.U.C.'s plots of isotherm-height suggest that there are similar periodicities in both sets of data, but with what appears to be a time-varying phase relationship. So far we have only found one case of obvious correlation over an interval greater than about 10 minutes. Figure 1 is a composite graph of the height of the 18-degree isotherm ( $H_{18}$ ),  $T_{2W}$ , and  $T_w$  over a 2-hour period on October 3. It shows a strong correlation between  $T_{2W}$  and  $T_w$  and suggests some degree of correlation between  $T_{2W}$  and  $H_{18}$  over a period of about 80 minutes.

In general, it does not appear that visual comparison of such graphs will lead to a definite conclusion about the existence of a relationship between internal waves and the radiometric surface temperature and/or temperature gradient, and that some form of numerical cross-correlation

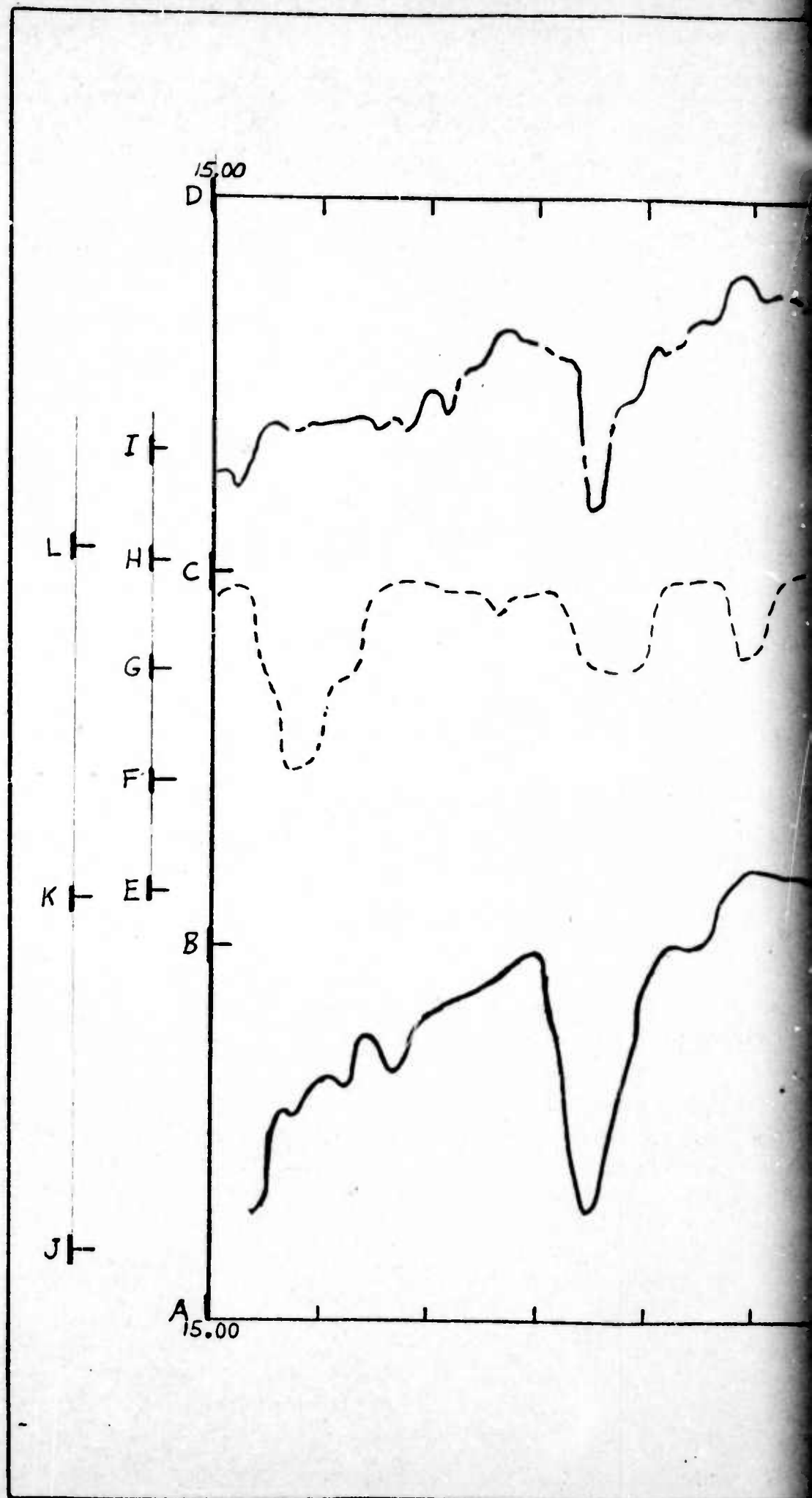
analysis will be required to come to such a conclusion. In a meeting at R & D Associates on February 22, P. Donahoe, R. Ziemer, M. Milder, S. Lubard and I selected portions of available data to be analyzed and correlated. Criteria included time of day, sky conditions, internal wave strength and uniformity, and wind speed, direction and steadiness. Two periods were chosen for initial analysis by R.D.A., both on October 3: 1500-1655 and 2230-0130 (October 4). The first of these periods is included in Figure 1.

*Stephen Rearwin*  
Stephen Rearwin

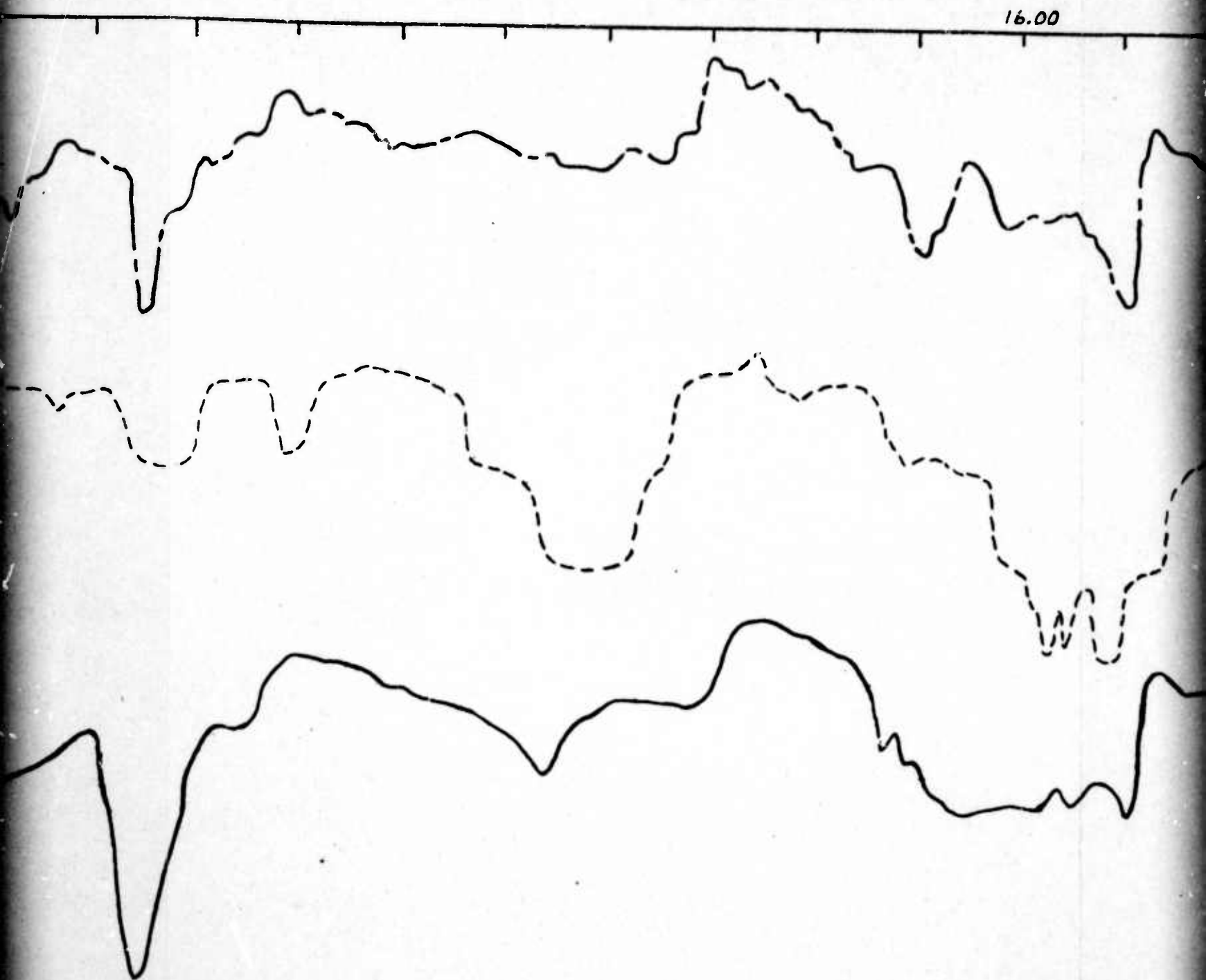
FIGURE CAPTION

Figure 1. Composite plot of the height of the 18-degree isotherm ( $H_{18}$ ), 4.8- $\mu$  surface temperature ( $T_{2W}$ ), and bulk-water temperature ( $T_W$ ) from 1500 to 1700 hours P.D.T. on October 3, 1972. Weather conditions: wind steadily dropping from 11 to 6 knots from 255 to 285°, sky radio-metrically clear, sea 1- to 2-foot swell at 10-sec. intervals with light to medium chop. The radiometer was looking north.





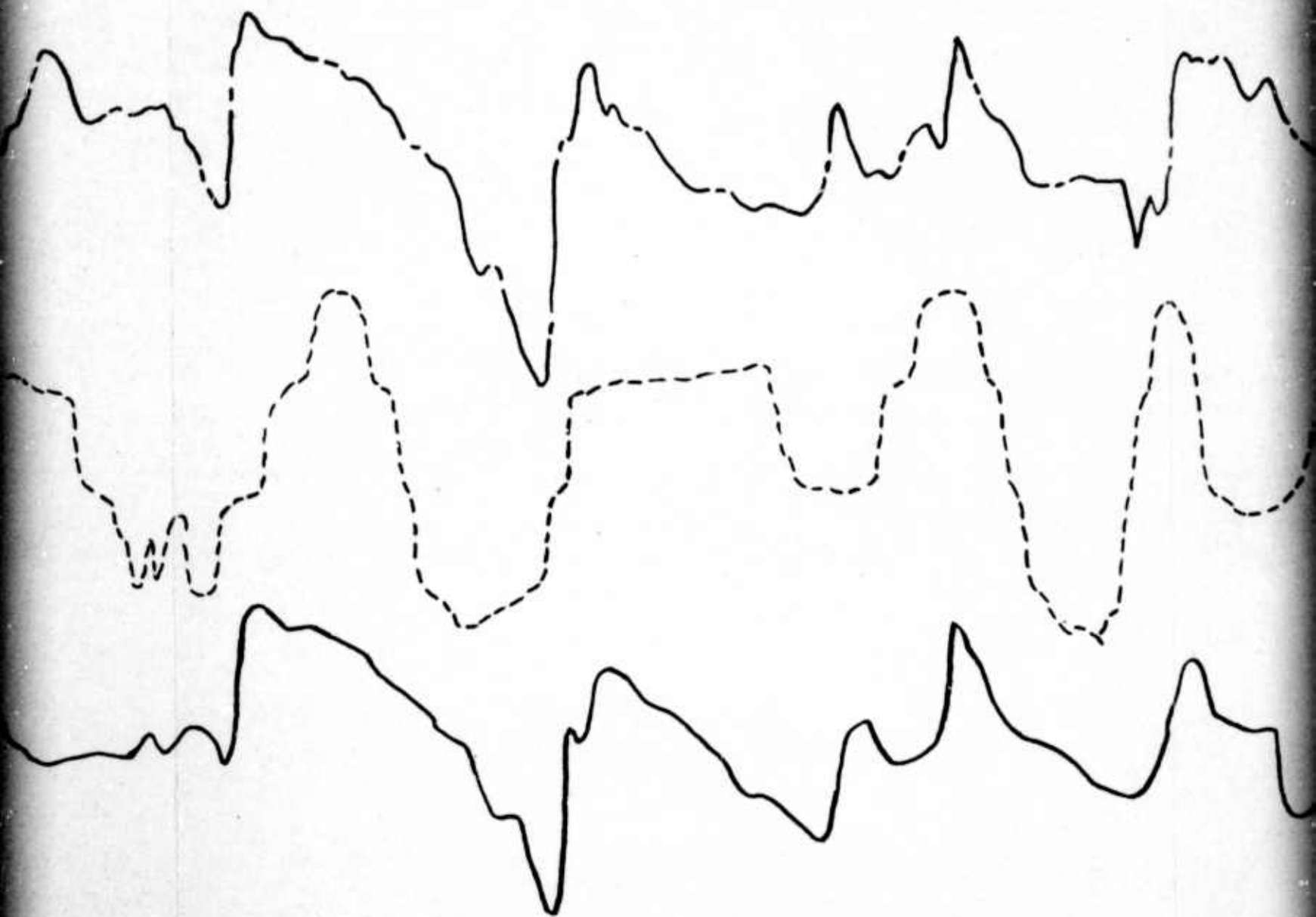




16.00  
HR of DAY OCT. 3, 1972

2

16.00



16.00

of DAY OCT. 3, 1972

3

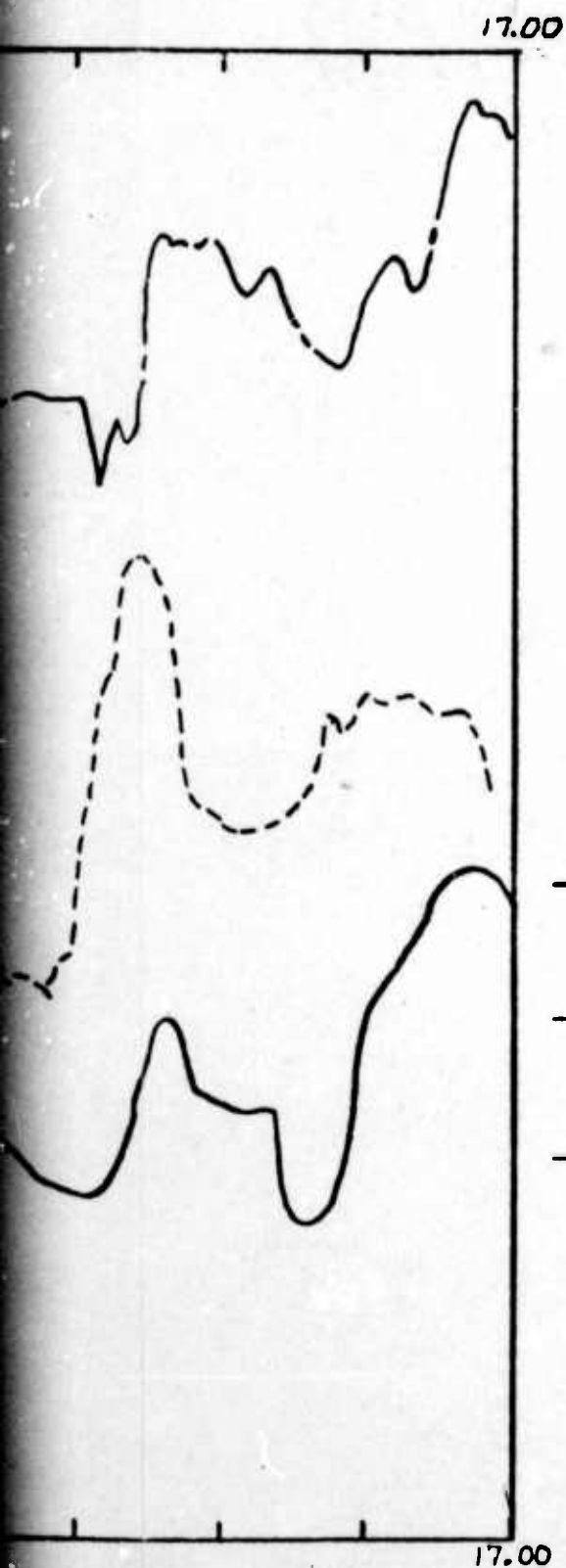


FIGURE 1

- TZW SCALE ABCD = 17.5°C  
TO 19.0°C
- 18°C ISOTHERM SCALE EFGHI =  
10 TO 18 METERS
- BULK WATER SCALE JKL =  
18.5 °C TO 19.5°C

TABLE 1

## 1972 TOWER DATA PERIODS FOR SCRIPPS' 2-WAVELENGTH RADIOMETER

Day	Date	Intervals (P.D.T.)	Tape (SRNT_)
242	Aug. 29	1329-1446	1
243	30	1703-1726	2
244	31	1315-1540	3
245	Sept. 1	1118-1351	4
256	12	2211-	5
257	13	-0055	
		0332-0625	6
269	25	2025-	7
270	26	-0526	
		0556-0744	8
272	28	1946-	9
273	29	-0353	
		0404-0807	10
277	Oct. 3	1230-1445	11
..		1500-2145	
..		2120-	12
278	4	-0748	
279	5	1222-1316	14
		1419-2051	
		2101-	15
230	6	-0601	
		0617-0859	16
		1135-1300 (?)	